Pulse Producer Decision Making Under Risky Conditions: Will End-Point Royalties Change Preferences?

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Abstract

In 2015, the Agriculture for Growth Act (C-18) came into effect in Canada. This Act modernized plant breeding by including amendments that aligned it with the 1991 International Convention for the Protection of New Plant Varieties (UPOV 91) (CFIA, 2017). Regulations within the Act grant plant breeders the right to charge an end-point royalty (EPR) on harvested grain. This thesis is interested in assessing how provenance and framing, influence pulse producer seed choice decisions. This study created a prospect theory behavioral experiment to answer this question. The study concluded that producers are not overly influenced by provenance and framing and instead make decisions based on the expected utility model, except when questions are manipulated by both EPR and negative framing. The study also concluded that most producers (56%) are willing to tolerate a level of risk. This provided a way to profile producers by risk tolerance and found many similarities and few minor differences between those that are always risk-seeking, always risk-averse, and occasionally risk-seeking.

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1. Introduction

A common policy problem is that theory proposes solutions and policy makers often emulate policy that worked in one area without evidence that will succeed in another. Policy should be evidence based. The study used end-point-royalties (EPRs) and specifically their success in Australian wheat breeding and applied it to Western Canadian pulse breeding. The study looked for evidence that pulse producers will behave in a similar manner to Australian wheat producers.

From food to fork, innovation has been at the center of Canadian agriculture. However, for research and development to flourish, sufficient funding for projects is necessary. Funding comes from various institutions, including public, private, and not-for-profit organizations. To risk their capital, many of these organizations require a sufficient return on investment (ROI). Excludability, which is the ability to exclude others from the use of private property, is a key element to generating an ROI. Usually, prospective users are required to pay a fee for the use of private property and those who do not pay are excluded from use. In plant breeding, there are various private property mechanisms that allow owners to charge a fee and generate an ROI on research and development. Some of the more common mechanisms include patents, copyright, industrial designs, trade secrets etc.

Pulse breeding in Saskatchewan is partially funded by a mandatory 0.67% checkoff on harvested grain and from other public and private institutions. Voluntary and mandatory checkoffs are not related to return on investment for intellectual property. Instead they were created by regulatory mechanisms that enable producers to charge a levy on harvested grain, regardless of the variety developer. Checkoffs are a policy instrument that allows producers to organize and charge levies to collectively fund research, market development, market extension,

and communications. Royalties embedded in seed price, royalties paid through contract technology use agreements, and end-point royalties are all intellectual property instruments that directly enable plant breeders to capture a return on their investments.

In Saskatchewan, the University of Saskatchewan Crop Development Centre (CDC) began pulse breeding in the 1970s. Because of inadequate pulse breeding funding, the CDC formed an agreement with the Saskatchewan Pulse Growers Association (SPG) in 1997. The CDC also partners with the University of Saskatchewan, the Government of Saskatchewan, BASF, and other organization to produce new pulse varieties. In return for their checkoff, Saskatchewan pulse producers access pulse varieties funded from this partnership royalty free. The levies are gathered by SPG to fund pulse breeding research, market development, and other pulse industry related activities.

Provisions in the Agriculture Growth Act (C-18) could incentivize private sector involvement in pulse breeding. Added funding by private firms in pulse variety development could generate superior yielding varieties for Canadian pulse producers but at a higher price. Industries that are dominated by the private sector can create a toll good environment that allows monopolies to flourish and charge monopoly prices for new plant varieties (Gray and Alston, 2013). As a result, Saskatchewan pulse producers will have the ability to choose pulse seed bred under various breeding systems and marketed under different royalty and pricing arrangements.

There are many theories that attempt to predict human decision making, the most prevalent being the rationally based models. These theories assume that human are rational beings and therefore will always choose the most rational option or the choice that generates the most utility. However, in 1979, Daniel Kahneman and Amos Tversky challenged the rational model of decision making and created Prospect Theory, which included an experiment that

concluded human choices are influenced by framing, even in a situation when the expected utility of options to a problem are equal. These theorists exposed a cognitive bias in human decision making in that individuals are not fully rational and framing influences preferences.

This study conducted a prospect theory behavioral experiment to study the effects of framing and provenance on pulse producer decision making. This study tested to determine if there is a pulse producer bias towards EPRs or checkoff funded varieties and bias towards positive and negative framing. To test these preferences, this study created a modified version of Asian Disease experiment made famous by Kahneman and Tversky. Respondents got two prospect theory problems which were allocated in a way that each got one questions related to a checkoff and one related to EPR. The problems were also differentiated in a way that all respondents received choices framed in the negative and positive domain. This study also asked various demographic and business related questions and cross tabulated some of these with data from the prospect theory questions to get a better idea of who the risk-seekers and risk-averse farmers are and where they get their decision-making information.

This study concludes that regardless of provenance or framing manipulations, most farmers choose the risk-averse option. Farmers are more likely to get information and advice on crop choices from personal experience, agronomists, family, and agri-business and less likely to get it from the internet and other media. Also, they overall prefer pulses, cereal, and oilseed financed through royalties imbedded in seed and voluntary checkoffs and least prefer mandatory checkoffs, technology use agreements, and EPRs. Most farmers are willing to accept some risk; I have tested for differences between those always risk-seeking, always risk-averse, and occasional risk-seekers.

Risk-seekers are generally the first adopters of technology and they also influence others to adopt a technology. For new biotechnologies like pulse seed breeding to move forward, risk-seekers need to adopt and grow new seeds. If Canada is to adopt a new seed breeding policy and system it is important to discover who the risk-seekers are in the pulse growing community and who they are influenced by to communicate effectively with them and to get their input on policy that affects them and the pulse sector.

2. Background

Intellectual Property

The World Intellectual Property Organization (WIPO) defines intellectual property (IP) as the "creations of the mind, such as inventions; literary and artistic works; designs; and symbols, names and images used in commerce" (WIPO, 2016.p.2). In Canada, there are various types of IP including patents, trademarks, copyrights, plant breeder's rights, and trade secrets. In Canada, each of these different mechanisms protects different types of knowledge, with varying time in which property can be protected.

Intellectual property allows "people to earn recognition or financial benefit from what they invent or create. By striking the right balance between the interests of innovators and the wider public interest, the IP system aims to foster an environment in which creativity and innovation can flourish" (WIPO, 2016, p.1). IP fosters innovation because it enables the owners to exclude others from using the property unless a monetary fee is paid. This incentivizes individuals to fund research and development because their future return of investment is protected from free-riders. Although IP can create an atmosphere where innovation can flourish, there are those that argue that IP creates a barrier to innovation.

2-1. Types of Intellectual Property		
Type of IP	What Does It Cover?	How Long is it Protected For
Trademarks	“One or a combination of words, sounds or designs used to distinguish the goods or services of one person or organization from those of others” (CIPO, 2016, p.2).	15 yrs. (CIPO, 2016, p.2)
Patents	"Cover new and useful inventions (product, composition, the machine, process) or any new and useful improvement to an existing invention" (CIPO, 2016, p.2).	20 yrs. (CIPO, 2016, p.2)
Copyright	"Provides protection for literary, artistic, dramatic or musical works (including computer programs) and other subject-matter knew as performer's performances, sound recordings and communication signals" (CIPO, 2016, p.2).	50 yrs. after the death of creator (CIPO, 2016.p.3)
Industrial Design	"Visual features of shape, configuration, pattern or ornament or any combination of these features applied to a finished article"(CIPO, 2016, p.2).	10 yrs. (CIPO, 2016, p.3)
PBR	New plant varieties (CFIA, 2016, p.6).	Trees and vines: 25 yrs. Other plant varieties: 20 yrs. (CFIA, 2016, p.6).

Some academics believe IP should be used in a limited sense. They view free competition as the default market condition and IP should have a limited use which would encourage innovation (Lemley, 2005). As opposed to the protectionist view of IP, this limited version does not allow owners to capture full rents. The result has “historically been intellectual property rights that are limited in time, limited in scope, and granted only to authors and inventors who met certain minimum requirements. On this view, the proper goal of intellectual property law is to give as little protection as possible consistent with encouraging innovation” (Lemley, 2005, p.1031). This weaker version of IP would allow owners to capture sufficient benefits to warrant investment in research and development yet would eventually allow others to benefit from this knowledge. UPOV 91 has been developed using this version of IP, because it allows developers to exclude others from using their protected seeds, yet allows academics to use these seeds

royalty free for the use of scientific research. This ensures that plant breeders and researchers both have incentives to work on and fund seed breeding innovation. Another reason is the germplasm-sharing agreements brokered by the Food and Agricultural Organization of the United Nations (FAO). This agreement allows plant breeders to use germplasm from other countries royalty free with the caveat that varieties created from these germplasms must be publically available to researchers.

The goal of the protectionists view on IP is to have an unlimited time frame and scope for IP. These scholars treat "intellectual property not as a limited exception to the principle of market competition, but as a good in and of itself" (Lemley, 2005, p.1031). They view intellectual property and real property as synonymous. In their view, "intellectual property is simply a species of real property rather than a unique form of legal protection designed to deal with public good problems" (Lemley, 2005, p.1031-1032). For example, just like individuals have the right to exclude others from real property, firms and inventors also has the right to exclude others indefinitely from using IP they have created and protected. These protections help creators internalize externalities and eliminate free-riding (Lemley, 2005).

Heller (1998), argues that a protectionist IP framework can create the tragedy of the anti-commons, which occurs when too many people can exclude others from the use of knowledge or property and this causes society to underuse resources (Heller, 1998). In this theory, many people own fragments of knowledge, but no individuals own a full bundle that would be necessary to innovate, so that each individual owner uses their IP to block others from obtaining the required knowledge to innovate (Heller and Eisenberg, 1998). This theory is opposed to the tragedy of the commons idea revived by Hardin in which insufficient excludability causes society to overuse a resource (Hardin, 1968).

Some believe that the protectionist view of intellectual property stifles innovation because strict IP law adds financial and time barriers to innovation. For example, Heller and Eisenberg (1998) argue that in the pharmaceutical industry's strong IP laws hinders the innovation of new drugs. Often, there are many components to a new medication, many of which are protected by IP law. As such, researchers must get permission to use these components to create new pharmaceuticals, which is costly in both time and money (Heller and Einsenberg, 1998). IP regulations therefore, make it more difficult to innovate in the pharmaceutical sector due to cost and time barriers that IP exposes them too.

The theoretical lineage of the protectionist view can be attributed to Garrett Hardin (1968) and Harold Demsetz (1967). These scholars argue that private property rights are required to prevent the over-usage and free-riding of resources (Demsetz 1967; Hardin 1968; Lemley 2004). Increasingly the executive, judicial, and legislative branches of government have taken this view on IP. Policy makers can see this by the increasing trend of stronger intellectual property rights through international organizations such as the WIPO and the World Trade Organization (WTO). Both organizations have specific rules and procedures for the creation and protection of IP. In the 1986-1994 WTO Uruguay negotiations, member countries negotiated the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) (WTO, 2016). This agreement gives the creator of intellectual property "the right to prevent others from using their inventions, designs or other creations and to use that right to negotiate payment in return for others using them" (WTO, 2016, p.1). This agreement has expanded IP from a domestic to an international scope in that a creator operating in different countries can bring their IP disputes to an international body for resolution.

Plant Breeders Rights

Plant breeder rights (PBRs) are a form of intellectual property designed to exclude competitors and producers from using the creator's products without consent. Canadian PBRs are framed under the weaker form of IP in that there is a regulated timeframe at which time PBR expires. There are then reproducibility exemptions for farmers and researchers that enable producers to save harvested certified seed and plant it in following years without paying a royalty (Plant Breeders Rights Act, 1990). Reproducibility also grounds farmer exemptions, such that farmers can save harvested seed and is royalty free.

The Canadian Food Inspection Agency (CFIA), "with the grant of a PBR for a new plant variety, the holder of PBR obtains exclusive rights in relation to the propagating material of their variety. The holder is then able to protect the variety from exploitation by others and can take legal action against individuals or companies that are conducting acts, without permission, that is the exclusive rights of the holder" (CFIA, 2016, p.1). The goal of these rights is to expand innovation in the plant breeding sector and like other forms of IP, provides specific policy tools to ensure these rights function properly.

In Canada, PBR is governed by the Plant Breeder's Rights Act (1990), which provides specific rules and regulation surrounding these rights. To qualify a variety must be new and have distinguishable, stable characteristics, and uniform characteristics (Plant Breeders Rights Act, 1990, s.4). This Act provides a specific definition of what these PBR qualifications mean. To be considered a new variety under this act "the propagating or harvested material of that variety has not been sold by, or with the concurrence of, the breeder of that variety or the breeder's legal representative" (Plant Breeders Rights Act, 1990.s.4(3)). This guarantees that only the creator of

the variety can apply for a PBR and protects against theft of this IP from competing individuals and firms.

A distinguishable characteristic is defined as having “one or more identifiable characteristics, clearly distinguishable from all varieties whose existence is a matter of common knowledge at the filing date of the application for the grant of plant breeder’s rights respecting that plant variety” (Plant Breeders Rights Act, 1990 s.4(2)). This clause ensures that a protected variety has new characteristics and protects identifiable features of the previously created plant being registered by someone other than the creators.

To have stable plant characteristics "a variety must remain true to its description over successive generations. The variety must be stable in its essential characteristics to the degree where further generations of seed or another propagating material exhibit the same characteristics of the variety as described in the variety description" (CFIA, 2016, p.3). This ensures plant characteristics are identical in subsequent generations. To be uniform “a variety must be sufficiently uniform in its relevant characteristics, subject to the variation that may be expected from the particular features of its propagation. Any variation should be predictable to the extent that it can be described by the breeder, and should be commercially acceptable” (CFIA, 2016, p.3). This ensures that when producers purchase a protected variety all seeds have identical characteristics for which they paid.

UPOV 91

The International Union for the Protection of New Varieties of Plant is an international IP agreement that allows individuals to protect under the law the unique properties that a new plant variety exhibits. There have been various versions of this act, the first one being in 1968,

followed by the 1972, 1978, and 1991 agreements (UPOV 91, 1991). Each Act has various amendments to strengthen plant breeder's rights. Per UPOV, this act exists "to provide and promote an effective system of plant variety protection, with the aim of encouraging the development of new varieties of plants, for the benefit of society" (UPOV 91, 1991, p.2). This international agreement encourages institutions to increase funding to the research and development of new plant varieties. UPOV encourages investment in the same way other forms of IP do in that it allows owners to exclude others from using their property without consent from the IP holder. The number of plant varieties protected post-UPOV 91 has been used as a measurement to quantify the international plant breeder's agreement success (Jordens and Buttons, 2011). This study concluded that UPOV 91 has been successful in encouraging the development of new plant varieties in Europe, North America, Asia, Latin America, the Middle East and Africa because there has been an increase in domestic and international plant breeding application filed in these areas of the world (Jordens and Buttons, 2011). Various clauses in the act help to achieve the success of UPOV internationally and domestically.

Under this agreement, a registered variety can be protected for 20 years and trees and vines can be protected for 25 years (Jordens and Buttons, 2011, P.76). This provides variety owners time to collect a return on their research and development investment. Variety owners can collect damages on "materials obtained through the unauthorized use of propagating material" (Jordens and Buttons, 2011, p.76). This section would help alleviate the free-rider problem that has plagued the creation of plant breeding in the past. With non-varieties, farmers can use and sell seed that was generated from the previous year's crop, with the caveat that producers are prohibited from using the variety name when marketing the seed to other producers for planting purposes. This is a problem for varieties owners because they only get

paid for the first year that their seeds are grown and do not get compensated when producers replant crops with saved seed. Under UPOV 78, a royalty is to be paid by the producer when they buy Certified Seed. This gives the owner of Certified Seed more than one chance at collecting royalties from the use of their product. Institutions would be more likely to fund new seed research and development if they can collect royalties in situations that did not allow them to collect under the current checkoff based plant breeding model.

2-2. Comparison of UPOV 1978 Act and UPOV 1991 Act		
Subject	UPOV 1978 Act	UPOV 1991 Act
Minimum scope of coverage	Increasing number of genera or species required to be protected, from five at time of accession, to 24 eight years later.	Increasing number of genera or species required to be protected, from 15 at time of accession, to all genera and species 10 years later (5 years for member states of earlier UPOV Act).
Eligibility Requirements	Novelty, distinctness, uniformity and stability.	Novelty, distinctness, uniformity and stability.
Minimum exclusive rights in propagating material	Production for purposes of commercial marketing; offering for sale; marketing; repeated use for the commercial production of another variety.	Production or reproduction; conditioning for the purposes of propagation; offering for sale; selling or other marketing; exporting; importing or stocking for any of these purposes.
Minimum exclusive rights in harvested material	No such obligation, except for ornamental plants used for commercial propagating purposes.	Same acts as above if harvested material obtained through unauthorized use of propagating material and if breeder had no reasonable opportunity to exercise his or her right in relation to the propagating material.
Prohibition on dual protection with patent	Yes, for same botanical genus or species.	No.
Breeders' exemption	Mandatory. Breeders free to use protected variety to develop a new variety.	Permissive, but breeding and exploitation of new variety "essentially derived" from earlier variety require right holder's authorization.
Farmers' privilege	Implicitly allowed under the definition of minimum exclusive rights.	Allowed at the option of the member state within reasonable limits and subject to safeguarding the legitimate interests of the right holder.
Minimum term of protection	18 years for grapevines and trees; 15 years for all other plants.	25 years for grapevines and trees; 20 years for all other plants.

Source: L.R. Helfer, 2004, Intellectual property rights in plant varieties: International legal regimes and policy options for national governments (FAO). http://www.fao.org/docrep/007/y5714e/y5714e03.htm#bm3.

According to the Canadian Seed Growers Association (CSGA), Certified Seed must conform to specific production processes that ensure that the traits developed by the breeder remain in successive generations of the seed (CSGA, 2017, p.1). There are three areas to this

production process: varietal purity, germination, and freedom of impurities (CSGA, 2017, p.1). Varietal purity ensures that Certified Seed has not been contaminated with any other seed during the production process (CSGA, 2017, p.1). The Canadian Food Inspection Agency (CFIA), ensures that all Certified Seed exhibit varietal purity and that germination is of Certified level (CSGA, 2017, p.1). Freedom of impurity is intended to assure that Certified Seeds have been developed according to regulations in the *Seed Act* and verified by a third-party inspector (CSGA, 2017, p1). Non-Certified Seed are those varieties not developed under Seed Act regulations.

Plant Breeding Models

There are various plant breeding institutional frameworks. In Canada, new canola varieties are bred under a private sector model and lentils are breed under a public-private-producer framework (P4). In Australia on the other hand, wheat is breed by privately owned companies, which are financed by an EPR. In Canada, canola is largely breed by multi-national organizations. These corporations also breed other commodities such as corn, soybeans, and cotton. Lentils in Canada are bred under a P4 framework, which includes producers, Saskatchewan Pulse Growers producer association, and the Crop Development Centre at the University of Saskatchewan. Currently, lentil breeding at the CDC is also funded by BASF (lentils), the Government of Saskatchewan through two research chairs in pea breeding and pulse pathology, operational support for field and grain quality screening, and the University of Saskatchewan for research and field infrastructure support and royalty investment into breeding.

Pulse Breeding in Saskatchewan

The University of Saskatchewan Crop Development Centre (CDC) (wholly-owned by the University of Saskatchewan) pulse breeding program began when Dr. Albert Slinkard was hired in 1972, and in 1978, the CDC released their inaugural lentil variety (Laird). In 1991, the CDC hired Dr. Bert Vandenberg and he began to use hybrid techniques to develop new pulse varieties. These events initiated a pulse breeding model in Saskatchewan which resulted from a market failure in pulse breeding to generate enough royalty revenue. Also, the model resulted from CDC's goal to provide pulse seed at cheaper cost and to provide momentum to the infant Saskatchewan pulse breeding industry. SPG was created in 1984 (CDC lentils varieties were already on the market) and in 1997 they formed a pulse breeding partnership.

In Saskatchewan, lentil variety development is currently supported under a public-private-producers-partnership; producer funds are from a producer levy on the sale of pulse crop. The University of Saskatchewan Crop Development Centre, conducts the physical research and development of new pulse varieties. These lentil producers pay a checkoff of 0.67% of the gross value of pulse sales to the producer association (SPG 2016). Checkoffs have not paid for the full cost of lentil variety development, whereas EPRs will supposedly cover the entire cost. Along with funding the research and development of new pulse varieties, farmers fund other SPG activities including pulse market expansions and development. This system also has flaws, one issue being freeriding on CDC varieties by producers in other provinces. Supporters of IP cite this problem as one reason why strong property rights are warranted. Under this system, producers in other provinces benefit from the investment pulse producers and other parties in CDC pulse varieties, yet do not financially contribute to the research and development of these varieties.

Australian Wheat Breeding

Alston and Gray (2013) and Alston, Gray and Bolek (2013) concluded that wheat breeding in Australia was plagued by under investment. To fix this problem, the Australian government legislated that wheat breeders could charge an EPR and a producer levy on all their protected wheat varieties (Alston and Gray, 2013, Alston, Gray, and Bolek, 2013). Both systems have been successful in generating new funding for the creation of new wheat varieties in Australia. These levies are collected by various research and development corporations (RDC), the largest being the Grains Research and Development Corporation (GRDC) (Gray and Alston, 2013).

After Australia signed onto the UPOV 91 agreement they could introduce legislation that conformed to international plant breeding IP standards, including EPRs. Thus, the GRDC discontinued their financial support of public wheat breeding frameworks and created a tender for the creation a three-private wheat breeding institutions. These companies are funded by an EPR, the Government R & D Corporation (GRDC), other public institutions, universities, and various private sources (Gray, Kingwell, Galushko, and Bolek, 2017, p.14). This is currently the dominant mechanism for Australian wheat breeding (Gray and Alston, 2013, p.32; Alston, Gray and Bolek, 2013, p.23). Although this system has been successful in attracting foreign and domestic investment in Australian wheat breeding, EPR plant breeding funding comes at a cost. EPR have created a toll good industry, "which is an industry that has inherent economies of size and barriers to entry, with incentives for market concentration and potential for monopoly pricing" and thus, prices for varieties produced by this system have been increasing (Gray and Alston, 2013, p.32). Thus, producers are susceptible to pay higher prices for seed compared to other Australian wheat breeders or Saskatchewan pulse breeding public, private, and levy based

systems but benefit from not being underfunded which could, therefore, produce superior varieties, relative to the underfunded levy based systems.

When the new EPR based Australian wheat breeding framework came into effect the corporation could not charge sufficient ERP immediately.

> [W]hen EPRs were first introduced, new EPR varieties had to compete with royalty-free varieties already used on farms. The availability of free varieties made it difficult to charge a significant EPR on the new varieties until they had improved to the point where producers were willing to pay a significant amount of EPR to access them (Alston, Gray, Bolek, 2012, p.25).

If the corporations charged significant EPRs early on, producers would have likely not purchased seed from these firms, because free seed could be sourced from public sources. Once crop yields on EPR-funded varieties improved, it made financial sense for them to purchase higher priced seed. With new PBRs in effect, it remains to be seen if they will incentivize private sector involvement in pulse breeding, and how they use EPRs to fund breeding, whether increased funding will lead to superior pulse varieties, whether an EPR/toll-good like pulse breeding framework will lead to high pulse seed prices and which frameworks SPG checkoff based or EPR based breeding will succeed?

According to Steve Jefferies, the former CEO of Australian Grain Technologies (AGT, the largest wheat breeder in Australia), EPR have changed Australian wheat breeding (Gray, Kingwell, Galushko, and Bolek, 2017, p.14). Before 2000, $18 million per year was invested in wheat breeding, 98% of which came from the public institutions. In 2015 under an EPR system, a $45 million per year was invested in wheat breeding, virtually of it coming from private sources (Gray, Kingwell, Galushko, and Bolek, 2017, p.14). Currently, the EPR Australian wheat breeding system operates 250,000 crop yield plots, whereas Canada operating under a non-EPR plant breeding system currently operates 80,000 plots (Gray, Kingwell, Galushko, and Bolek,

2017, p.14). This indicates that more wheat breeding is being conducted in Australia under their EPR system than in Canada under a public system. More research into wheat breeding in Australia has led to higher yielding wheat varieties than compared to varieties financed under any other system. Jefferies also indicated that wheat varieties Mace and Scepter, produced by AGT in 2008, on average yielded 3% and 7% higher than any other variety (Gray, Kingwell, Galushko, and Bolek, 2017, p.14) EPRs has led to greater revenue for wheat breeders in Australia, which consequently led to superior yielding wheat varieties.

3. Theoretical Framework

Prospect Theory

In 1981 Daniel Kahneman and Amos Tversky wrote the seminal paper in the field of behavioral economics. They developed a theory that challenged von Neumann and Morgenstern's (1947) rational model of decision making that individuals will chose the option that yields the highest expected utility. They argued that when making decisions humans have specific heuristic biases that will cause them to make the irrational decision (Kahneman and Tversky, 1979). Specifically, individuals make an irrational decision when they are presented with risk (Kahneman and Tversky, 1979). They called this system prospect theory and found that humans are risk-averse when making decisions when framed in the positive and risk-seeking in the negative (Kahneman and Tversky, 1979). The phenomena of these "outcomes are commonly perceived as positive or negative in relation to a reference outcome that is judged neutrally. Variations of the reference point can, therefore, determine whether a given outcome is evaluated as a gain or as a loss" (Kahneman and Tversky, 1981, p.456). There have been many attempts to replicate the results of Kahneman and Tversky's 1981 "Asian Disease Problem" with varying

results (e.g. Levin et al, 1998; Duckman 2001; Lubieniechi et al, 2016). A pair of meta-analyses (Kuhberger 1998; Pinon and Gambara 2005) concluded that although this study continues to see risk-averse behavior in the positive and risk-seeking in the negative when Kahneman and Tversky's experiment has been replicated, the results are small (Lubieniechi et al, 2016, p.725).

The Asian Disease Problem

Kahneman and Tversky's (1981) Asian disease problem explained the effect of framing in risky situations. In this experiment, Kahneman and Tversky presented this survey to respondents in their classical fashion; first, they presented a problem and then provided two options to solve the problem; one that is framed as a loss and one framed as a gain. In this experiment, the authors created a fictitious scenario where there is an outbreak of an Asia Disease in the US and 600 people are expected to die. They described the scenario as follows:

> *Imagine that the U.S. is preparing for the outbreak of an unusual Asian disease, which expected to kill 600 people. Two alternative programs to combat the disease have been proposed that are of equal expected utility. Assume that the exact scientific estimate of the consequences of the programs is as follows:*
>
> *Option #1:*
> *If Program A is adopted; 200 people will be saved.*
> *If Program B is adopted, there is 1/3 probability that 600 people will be saved and 2/3 probability that no people will be saved.*
>
> *Option #2:*
> *If Program C is adopted 400 people will die.*
> *If Program D is adopted there is 1/3 probability that nobody will die, and 2/3 probability that 600 people will die"* (Kahneman and Tversky, 1981, p.453).

3-1. Structure of the Asian Disease Problem				
Frame	Choice Option	Consequence	Expected Value	Study results (% of respondents)
Positive	Prospect A Prospect B	200 saved (1/3) 600 saved	200 saved (400 dead) 200 saved (400 dead)	72% 28%
Negative	Prospect C Prospect D	400 die (2/3) 600 die	400 dead (200 saved) 400 dead (200 saved)	22% 78%
Lubieniechi, Hesseln, Phillips, Smyth, 2016, p.721				

Both options have identical expected values, the difference between the two choices is that option #1 is framed as a gain (people being saved) and option #2 is framed as a loss (people dying). The result in the positive domain had 72% choosing the risk-averse options (prospect A) and 28% choosing the risk-seeking option (Prospect B) and in the negative domain, 22% chose the risk-averse option (Prospect C) and 78% chose the risk-seeking option (Prospect D) (Kahneman and Tversky, 1981). This experiment suggests that humans are risk-averse in the domain of gain and risk-seeking in the domain of loss because when the option was framed as gain respondents choose the risk-averse option and under the domain of loss they choose the risk-seeking option. This supports that there is a heuristic bias surrounding risk and framing. Even though the expected values are equal, people make irrational decisions when choices are framed differently.

Limitations to Prospect Theory

Although prospect theory has been influential in predicting human decision making in risky situations it has situational limitations. Druckman (2001), List (2003, 2004, and 2011) and Lubieniechi et al, (2016) argue that results can change when experiments are taken into real market situations instead of theoretical experimental settings. Druckman (2001), List (2003,

2004, 2011) and Lubieniechi et al, (2016) have concluded through behavioral experiments that the prospect theory works when an experiment is given to individuals with limited market experience but when the same experiment is given to individuals with market experience, they tend to choose the option with the highest expected utility. This limitation could affect this experimental test of Saskatchewan pulse growers. This study is attempting to see if Kahneman and Tversky's (1979, 1981) experiments are valid when testing pulse growers and their level of cognitive bias surrounding gains and losses in risky situations. The experienced farmers' sample could skew this study's prospect theory experimental results.

4. Experimental Design

This research focused on cognitive biases that affect Canadian pulse farmer decision making. More specifically this research studied how pulse farmers' decisions change when options are framed as a loss and as a gain in risky situations and determined farmer's provenance preferences. This study used the same experimental framework Kahneman and Tversky used in their famous Asian Disease Problem, except this research performed the experiment in the context of pulse producers and their willingness to purchase lentil seeds developed under checkoffs and an EPR system. This study created an experiment that tests framing and farmer seed preferences based on provenance. There were two versions of the behavioral experiment. Respondents got two questions; the questions were allocated in such a way that respondents got a question related to check off and one related to EPR and the questions were further differentiated by one in the gain domain and one in the loss domain. To answer this thesis' problem statement this study tests three hypotheses. These hypotheses have been tested many times. Lubieniechi et al. (2016) also tested them against framing and provenance and one key conclusion they reached

was “while framing has a strong impact on all participants’ choices, there is a weak and inconsistent provenance effect across results” (Lubieniechi et al, 2016, p.743), which violates expected utility theory.

This study used the experiment to test these three hypotheses:

- **$H0^1$**” The rate of choice will be 50% for each of Prospects A and B” (Lubieniechi et al, 2016, p.743).
- **$H0^2$** “$H0^1$ will hold for the positively framed and the negatively framed sets of Prospects A and B” (Lubieniechi et al, 2016, p.743).
- **H1**: A choice shift between the positive and negative framing will be observed such that risk aversion is more strongly induced by the positive condition than risk-seeking is induced by the negative condition (Lubieniechi et al, 2016, p.722).

In expected utility, if two options have the same expected utility then there should be a 50% chance to choose prospect A and 50% chance to choose prospect B (Lubieniechi, et al, 2016, p.721, Von Neumann and Morgenstern,1947). If these null hypotheses are valid, then framing should have no impact on which option respondents choose. Likewise, provenance should also have no impact on the results of this experiment since expected utility is the sole determinate. This study will test $H0^1$ against the 50/50 expected utility model and against Kahneman and Tversky (1981) conclusions. These hypotheses will allow this study to test the results of Kahneman and Tversky (1981) and von Neumann and Morgenstern (1947).

Kahneman and Tversky (1981), conclude that people are risk-averse in the positive/gain domain and risk-seeking in the negative/loss domain. This result is consistent with that of a choice reversal, in which significantly more than 50% of respondents chose in the risk-averse the positive, and significantly less than 50% of respondents chose the risk-seeking in the negative

(Lubieniechi et al, 2016, p.721, Druckman, 2001). However, most studies that replicated a version of the Asian Disease Problem yielded a choice shift, rather than a choice reversal (Lubieniechi et al, 2016). A choice shift occurs "when the rate of choice for Prospects A and B differs across the positively and negatively framed problems but a choice reversal is not observed" (Lubieniechi et al, 2016, p.722, Levin, 1998). This study created a prospect theory experiment to determine the number of risk-seekers and risk avoiders to determine if a choice shift or a choice reversal will be observed.

To examine these hypothesizes this study conducted the following prospect theory experiment. This study presented a prospect theory experiment to Western Canadian pulse farmers in which they need to choose between two different pulse varieties each with different yield potentials. This study framed one question as a gain and the other as loss and they were further differentiated by provenance. This will determine the validity of Ho^1 and Ho^2 and H1 and determine if pulse producers have a bias towards a specific provenance.

4-1. Structure of the Lentil Variety Problem (Target yield 25 bu/a)

Provenance	Frame	Choice Option	Consequence	Expected Value	Study results (% of respondents)
Checkoff	Positive	Variety A	All fields yield 20 bu/a	20 bu/ac gain	59%
		Variety B	1/4 fields yield 32 bu/a 3/4 fields yield 16 bu/a	20 bu/ac gain	41%
	Negative	Variety A	All fields yield 5 bus < target	20 bu/ac gain	66%
		Variety B	1/4 fields yield 7 bus > target 3/4 fields yield 9 bus < target	20 bu/ac gain	34%
EPR	Positive	Variety C	All fields yield 20 bu/a	20 bu/ac gain	59%
		Variety D	1/4 fields yield 32 bus/a 3/4 fields yield 16 bus/a	20 bu/ac gain	41%
	Negative	Variety C	All fields yield 5 bus < target	20 bu/ac gain	53%
		Variety D	1/4 fields yield 7 bus > target 3/4 fields yield 9 bus < target	20 bu/ac gain	47%

To determine which provenance (public checkoff or EPR) pulse producers prefer, this study asked respondents how strongly they prefer different pulse variety funding mechanisms (royalty

embedded in seed price, the royalty paid through contract technology use agreements, mandatory checkoff, voluntary/refundable checkoff, EPRs). This study also created a 2 X 2 table to express the percentage of risk-averse and risk-seekers in both frames. The study asked various demographic and business related questions, farmer provenance preference by crop type (pulses, cereals, oil seeds) and where farmers get information and advice on crop and how they feel about stacked varieties (Appendix A). A cross-tabulation was conducted between the 2 X 2 risk-averse versus risk-seeking table and the demographic and business related questions. A one-way ANOVA was also performed to see if there is a difference between pulses, cereals, and oilseeds as they relate to changing provenance. This offers insight into who these risk-averse and risk-seekers are and who and what influences their seed choice decisions.

This study surveyed members of the Western Canadian Wheat Growers Association (WCWGA), the Saskatchewan Pulse Growers Association (SPG) and producers at the Western Canadian Crop Production Show. This study surveyed WCWGA and SPG members online via the Voxco software available through the Social Science Research Laboratory at the University of Saskatchewan. Producers surveyed at the Crop Production show in Saskatoon were surveyed via hard copy. This study used the hard copy method at least partly in response to a concern that less technological savvy producers might decline to participate in an online survey, and partly to avoid technical challenges arising from limited public Wi-Fi service at the Crop Production Show (which ended up being the case). Respondents at the Crop Production Show were given a $5 Tim Hortons gift card as a thank you for their participation. This survey was approved on October 12, 2016, by the University of Saskatchewan Behavioral Ethics Board (BEH 16-332).

5. Results

Demographics

In total, this questionnaire was filled out by 127 farmers, 33 completed it online via the Voxco online software and the remaining were completed by hardcopy at the Western Canadian Crop Production Show in Saskatoon, from January 8th to 11th, 2017. The total number of acres these farmers seeded in 2016 ranged from 300 to 20,000. The mean amount seeded in 2016 was 5182 acres. This survey concluded that 83% of respondents have grown pulses within the last 5 years. In 2016, 34% of respondents seeded lentils, 50% seeded peas, 16% seeded chickpeas, 8% seeded fababeans and 5% seeded dry beans. This study also calculated the mean number of acres' respondents grew of each pulse crop in 2016 (5-1.).

5-1. Mean Number of Acres Seeded in 2016		
	Mean Acres Planted	*N*
Lentils	1514	43
Peas	670	64
Chickpeas	2500	2
Fababeans	273	10
Dry Beans	308	7

This study included 7% respondents from Alberta, 84% from Saskatchewan, 8% from Manitoba, and 0.8% from elsewhere. On average, farmers in the sample had been farming for 21 years. Overall, an overwhelming majority of respondents currently farm in Saskatchewan and are pulse producers. The average respondent also seeded a sizeable number of acres and had considerable farm experience.

Provenance Preference by Commodity

This study directly asked farmers which seed pricing mechanism they preferred for pulses, cereals, and oilseeds. Provenances included in this question were: royalties imbedded in seed price, royalties paid by technology use agreements, mandatory checkoffs, voluntary checkoffs, and EPRs. The composite and mean scores of each crop type are similar, suggesting there is not a strong preference for specific provenance within a crop type or between crop types.

5-2. Producer Provenance Preferences – Pulses Crops (binned)			
	Strongly/Moderately Against	Indifferent	Moderately/Strongly For
Composite Score	196 (32%)	200 (33%)	218 (35%)
Royalty imbedded in seed price	35 (28%)	34 (28%)	54 (44%)
Royalty paid through contract technology use agreements	43 (35%)	41 (34%)	37 (31%)
Mandatory checkoff	47 (38%)	40 (32%)	36 (29%)
Voluntary/refundable checkoff	28 (22%)	40 (32%)	57 (46%)
End-point royalties	43 (35%)	45 (37%)	34 (28%)

The composite scores for those respondents that are for, indifferent, and against specific provenances in pulse breeding and similar, indicating that roughly the same number of farmers fall in these three categories regardless of funding mechanism.

5-3. Pulse Provenance Preference - Mean	Mean	*N*
Royalty imbedded in seed price	3.11	123
Royalty paid through contract technology use agreements	2.82	121
Mandatory checkoff	2.8	123
Voluntary/refundable checkoff	3.22	125
End-point royalties	2.83	122

The mean score of different funding mechanism for pulse crops are similar, indicating that there is very little difference between producer preferences in pulse breeding.

5-4. Producer Provenance Preferences – Cereals (binned)			
	Strongly/Moderately Against	Indifferent	Moderately/Strongly For
Composite Score	200 (33%)	195 (32%)	210 (35%)
Royalty imbedded in seed price	41 (34%)	35 (29%)	45 (37%)
Royalty paid through contract technology use agreements	48 (40%)	43 (36%)	28 (23%)
Mandatory checkoff	46 (37%)	39 (32%)	38 (31%)
Voluntary/refundable checkoff	26 (21%)	34 (28%)	63 (51%)
End-point royalties	39 (33%)	44 (37%)	36 (30%)

Like pulse crops, the composite score of provenance preference in cereals are similar, which indicated that there are similar numbers of producers that fall into these three categories.

5-5. Cereal Provenance Preference Mean	Mean	***N***
Royalty imbedded in seed price	2.99	121
Royalty paid through contract technology use agreements	2.66	119
Mandatory checkoff	2.88	123
Voluntary/refundable checkoff	3.33	123
End-point royalties	2.94	119

The mean score of provenance preference in cereals are similar indicating that there is little difference between these funding mechanism preferences as they relate to cereals.

5-6. Producer Provenance Preferences – Oil Seeds (binned)			
	Strongly/Moderately Against	Indifferent	Moderately/Strongly For
Composite Score	199 (33%)	194 (32%)	212 (35%)
Royalty imbedded in seed price	40 (33%)	34 (23%)	46 (38%)
Royalty paid through contract technology use agreements	45 (37%)	44 (37%)	31 (26%)
Mandatory checkoff	46 (37%)	35 (28%)	42 (34%)
Voluntary/refundable checkoff	28 (23%)	39 (32%)	56 (45%)
End-point royalties	40 (34%)	42 (35%)	37 (31%)

The composite scores of producer provenance preferences with oilseeds are similar, indicating that there is little difference in the number of farmers that fall into these categories.

5-7. Oil Seed Provenance Preference - Mean	**Mean**	***N***
Royalty imbedded in seed price	2.97	120
Royalty paid through contract technology use agreements	2.75	120
Mandatory checkoff	2.89	123
Voluntary/refundable checkoff	3.23	123
End-point royalties	2.93	119

The mean score of oil seed provenance preferences are similar, indicating that there little different between these funding mechanisms and producer preference.

Behavioral Experiment Results

This study concluded that when checkoff financed lentil varieties are framed as a gain, pulse producers chose the risk-averse variety 59% of the time and the risk-seeking variety 41% of the time. When checkoff varieties are framed as a loss, pulse producers are likely to choose the

riskless variety 66% of the time and the risky 34% of the time. Therefore, Kahneman and Tversky's hypothesis that humans are risk-averse in the domain of gain is not rejected and the hypothesis that individuals are risk-seeking in the domain of loss is rejected. When EPR financed varieties are framed as a gain pulse producers are likely to choose the riskless option 53% of the time and the risky option 47% of the time. When EPR financed varieties are framed as a loss, pulse producers are likely to choose the risk-averse option 59% of the time and the risk-seeking option 41% of the time. Therefore, Kahneman and Tversky's hypothesis that humans are risk-averse in the domain of gain is not rejected and their hypothesis that humans are risk-seeking in the domain of loss is rejected.

5-8. Behavioral Experiment Results

Provenance	Frame	Preference
Checkoff	Positive	A = 59% (39) B = 41% (27)
EPR	Positive	C = 59% (36) D = 41% (25)
Checkoff	Negative	A= 66% (40) B = 34% (21)
EPR	Negative	C = 53% (35) D = 47% (31)

*A and C = risk-averse; B and D = risk-seeking

Under a positive framing, when producers were given the choice between EPR and checkoff financed lentil varieties, most producers choose the riskless option in both instances when the problem was framed as a gain. For EPR funded lentil varieties producers preferred the riskless (59%) option over the risky (41%) option. For checkoffs funded lentil varieties, producers also preferred the riskless (59%) option over the risky (41%) in the domain of gain. Under a negative framing, when producers were given the choice between EPR and checkoff varieties many producers chose the riskless option when these choices were framed as a loss. In the domain of loss, for EPR funded lentil varieties producers prefer the riskless (53%) option

over the risky (47%) option. For checkoff-funded lentil varieties producers prefer the riskless (66%) option over the risky option (34%). The results suggest that regardless of whether a lentil variety was financed by checkoffs or an EPR or if the problem was framed in the positive or negative, most producers in every scenario chose the riskless.

Information and Advice on Crop Choices

This study asked respondents "where do you get information and advice on crop choices." According to the responses, pulse producers are more likely to get information and advice on crop choices from personal experience (82%), agronomists (51%), family (53%), and agri-business (43%). They never or only occasionally get information from the media (53%) and the internet (38%).

5-9. Information and Advice on Crop Choices (Binned responses 1+2, 3, 4+5)			
	Never/Occasionally	Sometimes	Frequently/Always
Personal Experience	5 (4%)	17 (14%)	103 (82%)
Family	32 (26%)	26 (21%)	66 (53%)
Agronomists	18 (14%)	43 (34%)	64 (51%)
Agri-Business Companies	22 (18%)	48 (39%)	54 (43%)
Internet	46 (38%)	40 (33%)	34 (23%)
Media	62 (53%)	43 (37%)	12 (10%)

These results reveal that pulse producers prefer to get information and advice on crop choices directly from experience or other individuals directly instead of through a medium. Perhaps, producers prefer direct in person contact when gathering information on crop choices instead non-in person technologically mediated contact and that traditional forms of information gathering for decision making still dominate.

6. Analysis

Results 1: Behavioral Experiment Analysis

In this problem, farmers were given a choice, one of which was risk-averse and the other risk-seeking between two lentil varieties. The problems were further manipulated by provenance (checkoff and EPR) and framing (positive and negative).

Checkoff

The null hypothesis $H0^1$ failed to be rejected ($p = 0.14$) in the domain of gain with a p-value greater than 0.05 with 98% confidence, but was rejected in the domain of loss with a p-value of 0.015. Although, $H0^1$ failed to be rejected in the domain of gain, it was rejected in the domain of loss, therefore $H0^2$ is rejected. This means that framing does influence farmer decision making under checkoff manipulations, but only in the domain of loss. Hypothesis H^1 could not be rejected for both positively and negatively framed choices, therefore a choice shift was observed. In the positive 59% of farmers chose the riskless option while in the negative 66% of respondents also chose the riskless option. The choice shift was weak in that there was only a 7% shift. When the results of the problem were compared to Kahneman and Tversky's "Asian Disease Problem" the results differed significantly, with p-values of less than .05.

6-1. Wald Chi Square Comparison of Positively Framed Checkoff Outcomes Against $H0^1$		
	Variety A	Variety B
Observed Distribution	39 (59%)	27 (41%)
Expected Distribution	33 (50%)	33 (50%)
Wald Chi Square Result χ^2 (1) = 2.182, p = .014		

6-2. Wald Chi Square Comparison of Negatively Framed Checkoff Outcomes Against $H0^1$		
	Variety A	Variety B
Observed Distribution	40 (66%)	21 (34%)
Expected Distribution	30 (50%)	30 (50%)
Wald Chi Square Result: χ^2 (1) = 5.918, p = 0.015		

6-3. Wald Chi Square Comparison of Positively Framed Checkoff Outcomes Against the "Asian Disease" Results		
	Variety A	Variety B
Observed Distribution	39 (59%)	27 (41%)
Expected Distribution	47 (72%)	18 (28%)
Wald Chi Square Result: X^2 (1) = 5.456, p = 0.02		

6-4. Wald Chi Square of Comparison of Negatively Framed Checkoff Outcomes Against the "Asian Disease" Results		
	Variety A	Variety B
Observed Distribution	40 (66%)	21 (34%)
Expected Distribution	13 (22%)	48 (78%)
Wald Chi Square Results: X2 (1) = 67.494, p = <0.001		

End-Point-Royalty

The null hypothesis $H0^1$ and $H0^2$ failed to be rejected in the domain of loss (p = .622) and gain (0.159) with a p-value greater than .05. This means that framing under an EPR manipulation does not affect pulse producer decision making. Hypothesis H^1 could not be rejected under positive and negative framing. In the negative, 53% of respondents chose the risk- adverse option and in the positive, 59% of respondents chose the risk-averse option in the negative. There was a weak choice shift in that there was a shift of 6%. When the results were compared to Kahneman and Tversky's (1981) "Asian Disease" problem, the results differed significantly with p-values of less than 0.05.

6-5. Wald Chi Square Comparison of Negatively Framed EPR Outcomes Against H0[1]		
	Variety C	Variety D
Observed Distribution	35 (53%)	31 (47%)
Expected Distribution	33 (50%)	33 (50%)
Wald Chi Square Results: X2 (1) = .242, p = 0.622		

6-6. Wald Chi Square Comparison of Positively EPR Outcomes Against H0[1]		
	Variety C	Variety D
Observed Distribution	36 (59%)	25 (41%)
Expected Distribution	30 (50%)	30 (50%)
Wald Chi Square Results: X2 (1) = 1.984, p = 0.159		

6-7. Wald Chi Square Comparison of Negatively Framed EPR Outcomes Against the "Asian Disease" Results		
	Variety C	Variety D
Observed Distribution	35 (53%)	31 (47%)
Expected Distribution	14 (22%)	51 (78%)
Wald Chi Square Results: X2 (1) = 37.034, p < 0.001		

6-8. Wald Chi Square Comparison of Positively Framed EPR Outcomes Against the "Asian Disease" Results		
	Variety C	Variety D
Observed Distribution	36 (59%)	25 (41%)
Expected Distribution	44 (72%)	17 (28%)
Wald Chi Square Result: X2 (1) = 5.101, p = 0.024		

Result 2: Cereal, Oil Seed, and Pulse Funding Preferences

Producers were asked about their preferences regarding different seed funding mechanisms by crop type (pulses, cereals, and oilseeds) and provided with a 5 point Likert scale to test their preferences for royalty embedded in seed price, royalty paid through contract technology use agreements (TUA), mandatory checkoff, voluntary checkoff, and EPRs. The results were binned the responses in 3 categories: strongly/moderately against, indifferent, and moderately/strongly for and a mean of each response based on the 5 point Likert scale was

calculated. The composite and mean score of provenance preference by crop type revealed that there is not a strong preference for any specific mechanism.

Result 3: One Way ANOVA for Mean Cereal, Oil Seed, and Pulse Provenance Preferences

An ANOVA test was used to test for a difference between pulses, cereals, and oilseeds as they relate to different funding mechanism. This test concluded that there is no difference between oil seed, cereals, and pulses as they relate to farmer provenance preferences. The following composite scores were computed by calculating the average score of the five items evaluated for each cereal, oil seeds, and pulse crop on a 1 to 5 Likert scale. Each respondent evaluated all three crop types.

6-9. Provenance by Commodity Composite Score		
Cereal Varieties	Oil Seed Varieties	Pulse Varieties
N = 126; Mean = 2.9712	N = 126; Mean = 2.9869	N = 127; Mean = 3.0079

One-way ANOVA Results: F (2) = .071, p = .931

ANOVA was not significant (p=0.931), therefore subsequent tests were not conducted. The observed means of each crop type do not differ significantly from one another. This suggests that respondents may not feel differently about the way funds are raised based on the crop type evaluated.

Result 4: Risk Preferences by Framing

This behavioral experiment was designed to determine if pulse producers exhibit cognitive biases surrounding framing and provenance. In the problem, respondents had the ability to choose a risk-averse lentil variety or a risk-seeking variety under framing and provenance manipulations.

Table 6-10. identifies those who answered with the same risk versus inconsistent risk tolerances depending on the framing of the prospect theory question. The following table reveals that 44% of respondents are risk-averse in both frames and 26% are risk-seeking in both frames.

6-10. Risk Preference by Framing - 2 X 2		
	Negative	
Positive	Risk-averse respondents	Risk-seeking respondents
Risk-averse respondents	56 (44%)	23 (18%)
Risk-seeking respondents	15 (12%)	33 (26%)
Total		127

It reveals that 18% exhibit prospect theory behavior in that they are risk-averse in the positive/gain domain and risk-seeking in the negative/loss domain while 12% of respondent exhibit the opposite behavior. Therefore about 56% of respondents are willing to accept some level of risk and about 30% of farmer's exhibit irrational behavior because they switch their risk preference based on framing, when under a rational model total utility should be taken into consideration when making decisions. Identifying the number of risk-seekers and what and who influences their decisions is important for the adoption of new technology because risk-seekers are generally the first adopters of technology and are the influencers that move biotechnology and plant breeding forward. In the following section, cross tabulations between the various demographic questions identify who and what influences these pulse producers.

Result 5: Risk Tolerance Profiles

This study preformed cross-tabulations profiling respondents according to risk inclinations irrespective of gain or loss framing and between demographic, provenance preference by crop type and where producers are more likely to obtain information and advice on seed choice decisions. This study began by cross-tabulating the risk tolerance of these

respondents with their demographics. Respondents were binned into three categories based on their risk preferences: risk-seekers which includes those farmers that choose the risky option in both the positive and negative, riskless, which are those farmers that choose the riskless option in both frames, and occasional risky which include respondents that chose the risky option in only one frame. Most provenance preferences in each risk profile are marginal, indicating that there is a weak preference.

6-11. Demographic Profiles by Risk Preferences			
	Risk-seeking	Risk-averse	Occasional Risk
Did you Seed Pulse Crops in the Last 5 years?			
Yes	73%	86%	87%
No	27%	14%	13%
Province of farm			
Alberta	3%	12%	3.0%
Saskatchewan	94%	79%	84%
Manitoba	3.0%	7%	13%
Other	0%	1.8%	0%
Total Acres Seeded in 2016?			
1-5000	69%	59%	67%
5001-10,000	19%	36%	25%
10,001 - 15,000	3%	0%	6%
15,001- 20,000	9%	5%	3%
Lentils (acres)			
1 – 5,000	71%	62%	60%
1,501 – 3,000	0%	24%	33%
3,001 – 4,500	0%	5%	0%
4,501 – 6,000	29%	9%	7%
Peas (acres)			
1 – 500	38%	47%	58%
501 – 1000	54%	37%	26%
1001 – 1500	8%	12%	16%
1501 – 2000	0%	3.1%	0%
Years Farming			
1 – 15	50%	49%	47%
16-30	28.%	24%	19%
31-45	22%	21%	28%

The survey also asked the respondents where they got their agronomic information. The following tables break out the responses by the risk preferences of the respondent. There are a

few interesting differences. Generally, risk-seekers rely more on family, agribusiness and the media for advice. Risk-averse producers draw from all the identified sources relatively consistently.

6-12. Agronomic Information from Family by Risk-Preference			
	Risk-seeking	Risk-averse	Occasional Risk
Never	6%	9%	13%
Occasionally	9%	11%	30%
Sometimes	12%	28%	19%
Frequently	51%	39%	16%
Always	21%	13%	22%

6-13. Agronomic Information from Agri-Business by Risk-Preference			
	Risk-seeking	Risk-averse	Occasional Risk
Never	3%	2%	6%
Occasionally	9%	12%	22%
Sometimes	19%	54%	33%
Frequently	56%	20%	28%
Always	12%	12%	11%

6-14. Agronomic Information from the Internet by Risk-Preference			
	Risk-seeking	Risk-averse	Occasional Risk
Never	27%	10%	6%
Occasionally	24%	29%	20%
Sometimes	18%	31%	51%
Frequently	27%	25%	20%
Always	3%	6%	3%

6-15. Agronomic Information from the Media by Risk-Preference			
	Risk-seeking	Risk-averse	Occasional Risk
Never	29%	27%	18%
Occasionally	19%	35%	26%
Sometimes	35%	29%	50%
Frequently	13%	10%	3%
Always	3%	0%	3%

6-16. Agronomic Information from Agronomists by Risk-Preference			
	Risk-seeking	Risk-averse	Occasional Risk
Never	0%	2%	3%
Occasionally	9%	16%	11%
Sometimes	36%	36%	30%
Frequently	39%	36%	49%
Always	15%	9%	8%

6-17. Agronomic Information from Personal Experience by Risk-Preference			
	Risk-seeking	Risk-averse	Occasional Risk
Never	3%	0%	3%
Occasionally	3%	2%	3%
Sometimes	6%	11%	24%
Frequently	54%	58%	40%
Always	33%	29%	30%

6-18. Agronomic Information from Other Farmers by Risk-Preference			
	Risk-seeking	Risk-averse	Occasional Risk
Never	0%	0%	3%
Occasionally	6%	7%	11%
Sometimes	24%	28%	27%
Frequently	48%	46%	40%
Always	21%	18%	19%

This study also broke out the questions about preferences for seed financing mechanisms by the risk preferences of the producer respondents. There were no glaring differences among the groups and their preferences. Generally, risk-averse producers were more tolerant of all the methods.

6-19. Cereal Varieties Funded by Royalty Imbedded in Seed Price by Risk-Preference			
	Risk-seeking	Risk-averse	Occasional Risk
Strongly Against	18%	11%	17%
Moderately Against	18%	19%	20%
Indifferent	24%	34%	26%
Moderately For	24%	26%	29%
Strongly For	15%	9%	9%

6-20. Cereal Varieties Funded by TUA by Risk-Preference			
	Risk-seeking	Risk-averse	Occasional Risk
Strongly Against	19%	15%	23%
Moderately Against	28%	21%	17%
Indifferent	34%	42%	29%
Moderately For	16%	21%	29%
Strongly For	3%	0%	3%

6-21. Cereal Varieties Funded by Mandatory Checkoff by Risk-Preference			
	Risk-seeking	Risk-averse	Occasional Risk
Strongly Against	15%	9%	22%
Moderately Against	27%	24%	17%
Indifferent	30%	33%	31%
Moderately For	18%	24%	22%
Strongly For	9%	9%	8%

6-22. Cereal Varieties Funded by Voluntary Checkoff by Risk-Preference			
	Risk-seeking	Risk-averse	Occasional Risk
Strongly Against	12%	17%	13%
Moderately Against	3%	7%	8%
Indifferent	30%	28%	24%
Moderately For	36%	32%	32%
Strongly For	18%	15%	22%

6-23. Cereal Varieties Funded by EPR by Risk-Preference			
	Risk-seeking	Risk-averse	Occasional Risk
Strongly Against	18%	12%	14%
Moderately Against	12%	16%	29%
Indifferent	33%	39%	37%
Moderately For	21%	22%	14%
Strongly For	15%	12%	6%

6-24. Oil Seed Varieties Funded by Royalty Embedded in Seed Price by Risk-Preference			
	Risk-seeking	Risk-averse	Occasional Risk
Strongly Against	19%	15%	17%
Moderately Against	12%	17%	19%
Indifferent	19%	35%	28%
Moderately For	34%	29%	28%
Strongly For	16%	4%	8%

6-25. Oil Seed Varieties Funded by TUA by Risk-Preference			
	Risk-seeking	Risk-averse	Occasional Risk
Strongly Against	16%	11%	22%
Moderately Against	29%	21%	17%
Indifferent	26%	47%	31%
Moderately For	29%	19%	25%
Strongly For	0%	2%	6%

6-26. Oil Seed Varieties Funded by Mandatory Checkoff by Risk-Preference			
	Risk-seeking	Risk-averse	Occasional Risk
Strongly Against	16%	7%	30%
Moderately Against	25%	26%	11%
Indifferent	25%	33%	24%
Moderately For	34%	24%	19%
Strongly For	0%	9%	16%

6-27. Oil Seed Varieties Funded by Voluntary Checkoff by Risk-Preference			
	Risk-seeking	Risk-averse	Occasional Risk
Strongly Against	12%	15%	16%
Moderately Against	6%	9%	8%
Indifferent	41%	28%	30%
Moderately For	31%	35%	24%
Strongly For	9%	13%	22%

6-28. Oil Seed Varieties Funded by EPR by Risk-Preference			
	Risk-seeking	Risk-averse	Occasional Risk
Strongly Against	19%	13%	17%
Moderately Against	16%	15%	22%
Indifferent	26%	35%	44%
Moderately For	23%	27%	6%
Strongly For	16%	10%	11%

Pulse producers, the focus of this work, warrant a brief discussion. Generally, risk-seekers and occasional risk takers had wider diffusion of opinions, being both more antagonistic and more supported of each method than risk-averse producers.

6-29. Pulse Varieties Funded by Royalty Imbedded in Seed Price by Risk-Preference			
	Risk-seeking	Risk-averse	Occasional Risk
Strongly Against	21%	13%	16%
Moderately Against	0%	13%	22%
Indifferent	15%	40%	22%
Moderately For	42%	30%	24%
Strongly For	21%	4%	16%

6-30. Pulse Varieties Funded by TUA by Risk-Preference			
	Risk-seeking	Risk-averse	Occasional Risk
Strongly Against	16%	15%	19%
Moderately Against	25%	19%	13%
Indifferent	31%	40%	27%
Moderately For	25%	23%	35%
Strongly For	3%	2%	5%

6-31. Pulse Varieties Funded by Mandatory Checkoff by Risk Preference			
	Risk-seeking	Risk-averse	Occasional Risk
Strongly Against	18%	13%	24%
Moderately Against	27%	19%	16%
Indifferent	21%	40%	32%
Moderately For	30%	21%	19%
Strongly For	3%	7%	8%

6-32. Pulse Varieties Funded by Voluntary Checkoff by Risk Preference			
	Risk-seeking	Risk-averse	Occasional Risk
Strongly Against	15%	15%	13%
Moderately Against	9%	6%	10%
Indifferent	24%	37%	32%
Moderately For	39%	31%	26%
Strongly For	12%	11%	18%

6-33. Pulse Varieties Funded by Voluntary Checkoff by Risk Preference			
	Risk-seeking	Risk-averse	Occasional Risk
Strongly Against	27%	15%	16%
Moderately Against	15%	13%	21%
Indifferent	24%	40%	43%
Moderately For	15%	27%	11%
Strongly For	18%	4%	8%

6-34. Pulse Varieties Funded by Stacked Royalty Mechanism by Risk Preference			
	Risk-seeking	Risk-averse	Occasional Risk
Strongly Opposed	39%	14%	32%
Moderately Opposed	24%	29%	16%
Indifferent	21%	45%	16%
Moderately Support	15%	12%	3%
Strongly for	0%	0%	0%

Always Risk-Seeking

The respondents in this category are defined as those choosing the risky choice in both the positive and negative frames. Of those farmers that are always risk-seeking, 73% are pulse producers and 94% of them farm in Saskatchewan. They generally have small farms, with 69% seeding between 1 and 5000 acres in 2016. Most seeded between 1 to 5000 acres of lentils and 501 to 1000 acres of peas in 2016. Also, they tend to be less experienced producers, having farmed between 1 and 15 years. They most frequently got advice and information on seeding decision from family, agri-business companies, agronomists, personal experience, and other farmers, and less likely to get it from the internet and media. There is a consensus with regard to which preference of provenance by crop type. In pulses, cereals, and oil seeds, risk-seekers most prefer seeds financed by royalty imbedded in seed price and voluntary checkoffs, and least prefer seeds financed by mandatory checkoffs, TUA, and EPR.

This study also profiled always risk-seekers by where they get information and advice on crop choices. These individuals are more likely to get information and advice from family (73%), agri-business (69%), agronomists (55%), personal experience (88%), and other farmers (70%), and less likely to get it from the media (48%), and the internet (51%). These results are consistent with the aggregate information and advice on crop choices results.

Always Risk-Averse

The respondents in this category are defined as choosing the risk-averse option in both the domain of loss and gain. The demographics of this category are almost the same as the always risk-seekers, the only difference being that they seeded fewer peas in 2016. Those that are always risk-seeking tended to seed between 501 – 1000 acres of peas on 2016 (54%), whereas the plurality of the always risk-averse seed between 1 and 500 acres of peas (47%).

Like the risk-seekers, the avoiders most prefer voluntary checkoff for all crop types; however, these individuals are more indifferent with regards to the funding method by crop types than the risk-seekers. In all three crop types, the risk avoiders are indifferent with regards to their preference of royalty imbedded in seed price, TUA, and EPR. There is a difference between crop types on their preference regarding mandatory checkoffs, with pulses and oil seeds, these respondents are indifferent, however, with cereals, they least prefer mandatory checkoffs.

Overall, risk-seekers have more consensuses between preference by crop type than always risk-averse and occasional risk-seekers. The always risk-averse, are largely indifferent than with the other two profiles. There is a strong dislike for voluntary checkoffs for all three profiles and a general dislike for mandatory checkoffs for all three crop types. There are fewer consensuses with regards to EPR, for the three crop types.

The always risk-seekers are more likely get their information and advice on crop choices from the same sources as the risk-seekers, except they are less likely to get information from agri-business than risk-seekers.

Occasional Risk-Seekers

These individuals are willing to take some risk in one frame but not in the other. Demographically, these producers are the same as those who are always risk-seekers. Like the other two profiles, occasional risk-seekers prefer voluntary checkoffs for all crop types. They least prefer mandatory checkoffs for all three crop types. However, there are fewer consensuses between crop types than the other profiles. For pulses and cereals, these producers prefer royalty imbedded in seed price, yet for oil seeds there were equal number (36%) that prefer and do not prefer this type of provenance. Also, with regards to EPRs, these individuals were indifferent when they were charged on pulses and oil seeds, but there is a preference for using EPR for cereals. They also prefer TUAs on pulses, yet do not prefer them on oil seeds and cereals.

Those who are occasionally risk-seeking get information and advice on crop choices most frequently from the same sources as those which are always risk-seeking, except that most the occasional risk-seekers sometimes get information from the media (50%) and the internet (51%), whereas those in the other two profiles never or occasionally get their info from these sources.

Limitations

This study did not ask a baseline behavioral experiment question, meaning that this research did not include a question without provenance manipulations. This would have allowed a comparison with and without provenance manipulations, which would have provided more evidence regarding the influence provenance has on producer seed decision making. The part of the behavioral question that discussed manipulations was bolded which allowed respondents to better clarify the difference between the two problems. In retrospect, this could have potentially introduced some bias. While this study worded the behavioral questions in the same manner as

Kahneman and Tversky (1981), in some instances this could have made it difficult for respondents to properly solve and answer the questions.

7. Conclusion

The issue of how to fund breeding in Canadian pulses is on the agenda of breeders for the first time in a very long time. The traditional P4 pulse breeding model has been the dominant framework, however, EPRs and their success in Australia wheat breeding has caused the industry to take a second look at pulse breeding. To predict the future of pulse breeding in Canada, it is useful to determine producer biases towards provenance and if they are influenced by cognitive biases such as framing. Will they choose seed based on profitability or do other factors such as framing or provenance have an effect? In traditional decision-making theory, it is assumed that people are rational beings, so that when farmers have multiple seed choices, they will choose the most profitable one regardless of other influences such as risk or framing or provenance. Eventually, Australian producers chose the rational profit maximizing wheat variety if pulse producers are perfectly rational, they too should choose the same option, but Kahneman and Tversky proved that people are not 100% rational because they are influenced by more than just utility.

This study performed a prospect theory experiment to test if provenance and framing influence pulse farmers' decision making. This study gave each respondent a problem where one question was framed as an EPR or checkoff and one question had a positive or negative framing manipulation. In all the questions, most farmers chose the riskless position. This study preformed Chi Squares to test the statistical significance of the results against $H0^1$ and $H0^2$ concluding that only in the checkoff/loss manipulation did farmers' risk tolerance significantly veer from the

50/50 expected utility theory ($H0^1$). In the checkoff manipulation, farmers exhibited rational behavior as per expected utility theory in the positive but behaved irrationally in the negative. Because framing influenced risk tolerance in the negative, $H0^2$ was rejected. Under EPR manipulations $H0^1$ and $H0^2$ failed to be rejected, therefore farmers exhibited rational behavior and were not influenced by provenance and framing when presented with varieties created under an EPR. This study tested the behavioral question results against Kahneman and Tversky (1981) "Asian Disease*"* problem and found that there was a significant difference between the two results.

This study then created a 2 X 2 table to profile the respondents based on risk tolerance. The three profiles are always risk-seeking, always risk-averse, and occasionally risk-seeking were constructed based on the behavioral experiment results. The study found that 44% of farmers are risk-averse under both frames, 26% are risk-seeking under both frames, 18% of farmers have prospect-theory-like behavior and 12% of people behave in the reverse manner (risk-seeking in the positive domain and vice versa). Overall, 56% of farmers are willing to take some level of risk and 44% are unwilling to take any risk.

This study asked farmers their preferences on funding mechanism by commodity (pulses, oilseeds, cereals) and the composite and mean scores for each crop type revealed there is not a strong preference for a provenance. This study also, preformed a one-way ANOVA on the composite scored of each crop type and found there was no difference between crop types and provenance preferences. Therefore, their stated preference which was exposed in the provenance questions and their revealed funding mechanism preference in the behavioral experiment were similar except in the checkoff/loss question.

The study then wanted to profile the respondents by asking a series of demographic and problems about where they get information and advice on crop choices. This study found that a significant number of respondent's farm in Saskatchewan and seed pulse crops and that preference about funding mechanism across crop types are similar. This study also concluded that farmers tend to get information and advice on crop choices from family, agri-business companies, personal experience, and from other farmers and are less likely to get it from the internet and media, indicating that traditional forms of information gathering still dominate.

Finally, this study cross-tabulated the three risk profiles with the results from the information and advice questions and the funding mechanism preference by crop type to explore where individuals with different risk tolerances get their information and which mechanism do they prefer. The study found that the demographics of all three risk profiles are nearly identical, except that the always risk-averse seeded more acres of peas in 2016. The three risk profiles mostly prefer voluntary checkoffs in all three crop types. The always risk-seekers have clear mechanism preference, the always risk-averse are largely indifferent with regards to funding mechanisms than the other two profiles, and there is less consensus between funding mechanism by crop type for the occasional risk-seekers than the other profiles. There is near consensus on where these groups get their information and advice on crop decision from. They are all more likely to get it from family, agri-business, agronomists, personal experience, and other farmers. However, most of the occasional risk-seekers sometimes information from media (50%) and the internet (51%), whereas the individuals in the other two risk profiles are, least likely get it from these sources.

What do these results say about the Saskatchewan pulse breeding system and possible changes to this model resulting from EPR's? Risk-seekers are important drivers of plant breeding

because they are the early adopters of new varieties and therefore influence others to also adopt and driving one variety over another forward. The good news is that most of the producers surveyed (56%) are willing to take some amount of risk. Therefore, most pulse farmers can be early adopters of new pulse varieties and influence others to grow new pulse varieties. Generally, pulse producers are rational thinkers because they tend to behave closer to the 50/50 expected utility model regardless of checkoffs or EPR. They are generally utility maximizers; the study revealed they are more likely to choose the pulse variety that generates them more profit, regardless of the funding mechanism used. This means that most pulse producers would be willing to take some risk and adopt new varieties if there was the possibility of higher profits than alternative options.

Through the behavioral experiment, it was revealed that the funding mechanism (checkoffs over EPRs) does not influence producer seed choices. This could give future pulse breeders greater flexibility when making plant breeder rights decisions. If producers are indifferent with regards to the funding mechanism, and primarily interested in profit maximization, then plant breeders could create an intellectual property framework for plant breeding that allows them to generate the greatest ROI, so long as these pulse varieties continue to generate more profit for producers than previous varieties.

Policy makers emulate policy from other areas without evidence that it will succeeds in their jurisdiction. Policy should be evidence based and in this thesis, this study took EPRs and their success the Australian wheat breeding and applied it to pulse breeding. This study looked for evidence that Australia wheat producers and Western Canadian pulse producers behave the same way to varieties financed by EPRs. Once EPRs funded Australian wheat varieties had high enough yields, producers began to favor them over the levy funded varieties. In effect, they

displayed rational profit maximizing behavior. The results showed that Western Canadian pulse producers are mostly rational (confirmed by lack of evidence of prospect theory responses, except modest risk shifting in the domain of loss) and are willing to take risk and seed new varieties regardless of provenance. In response, this study tested to find how famers get information and advice on seeding decision to determine if or how technology adoption might be enhanced. This study identified the common pathways of communications but determined this aspect would benefit from further research.

This study concluded that 56% of Western Canadian farmers are willing to take some degree of risk and therefore most of them would most likely be early to mid-adopters of technology and new inventions. If the goal is to grow more lentils in Saskatchewan, then industry and policy makers may find value in focusing on influencing these primary adopters to seed more lentils. These adopters would then persuade more producers to plant lentils.

Over the last 40 years, Saskatchewan has created a lentil breeding cluster which has attracted experts and capital that has allows breeders to innovate and create new lentil varieties and, in the process, position the province as a world leader in lentil research, development and production. The introduction of EPRs in Saskatchewan could have the potential to attract even more capital and plant breeding to the province. This lentil breeding infrastructure could create substantial opportunities for Saskatchewan producers. They could have access to higher yielding lentils and varieties with new traits that would enable these varieties to strive in the prairies. However, more producers must adopt new lentils varieties for the province to take full economic advantage of such efforts. If policy makers what to increase lentil production in the prairies, it would be beneficial to understand these risk-seeker at a more in-depth level. We need to know

what makes some producers early adopters of technology and what institutions could do to create an atmosphere where more lentils are planted annually.

This study has concluded that farmers get their agronomic information more from their social network that from media sources. Policy makers may get value by mapping these social systems to get a more in-depth picture of what (agronomics) and who (social networks) influences farm seeding decisions. This would enable policy makers to more accurately locate risk seekers and target their messages to them. If we can find those risk seekers and primary adopters, then we could learn more factors beyond framing that influence seed decision making.

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Appendix A – Survey Questions

Version 1

Survey:

1. Are you involved in farm-level related decision making?

Yes	
No	

IF NO, thank you for your interest. We have no further questions for you.

2. Imagine you are planning your crop production choices for 2017, and you plan on planting some lentils. You need an average return of 25 bu/a to earn your target profit on that crop**. You have 2 alternative crop varieties to choose from. Both are public varieties available without royalties but are subject to producer checkoffs**. If variety A is adopted the crop will yield 20 bu/ac. If variety B is adopted, 1 in 4 fields will yield 32 bu/a but 3 out of 4 fields will yield 16 bu/ac.

Variety A	
Variety B	

3. Imagine you are planning your crop production choices for 2017, and you plan on planting some lentils. You need an average return of 25 bu/a to earn your target profit on that crop**. You have 2 alternative crop varieties to choose from. Both are privately contracted niche varieties not subject to producer check-offs but obligated to pay end-point royalties of an equivalent amount**. If variety C is adopted, the crop will yield 5 bu/acre less than the target, if variety D is adopted, 1 in 4 fields will yield 7 bu/a more than the target and 3 out of 4 will yield 9 bu/a less than the target.

Variety C	
Variety D	

Please tell us a little bit about yourself (Please tick the appropriate boxes or enter the data)

4. Have you seeded pulse crops (lentils, beans, peas) within the last 5 years?

Yes	
No:	

5. What Province do you farm in?

British Columbia	
Alberta	
Saskatchewan	
Manitoba	
Other	

6. How many acres of all crops did you seed on your farm in 2016?

7. How many acres did you plant in 2016 to:

Lentils	
Peas	
Chickpeas	
Fababeans	
Dry beans	

8. How many years have you been farming?

9. Where do you get information and advice on crop choices?

	Never	Occasionally	Sometimes	Frequently	Always
Family					
Agri-business companies					
Internet					
Media					
Agronomists					
Personal experience					
Other Farmers					

10. There are multiple ways to raise funds for research into agronomy and new varietal development. For the following questions, please indicate your preference by crop type:

FOR PULSES	Strongly Against	Moderately Against	Indifferent	Moderately For	Strongly for
Royalty imbedded in seed price					
Royalty paid through contract technology use agreements					
Mandatory checkoff					
Voluntary/refundable checkoff					
End-point royalties					

FOR CEREALS	Strongly Against	Moderately Against	Indifferent	Moderately For	Strongly for
Royalty imbedded in seed price					
Royalty paid through contract (e.g. technology use agreements)					
Mandatory checkoff					
Voluntary/refundable checkoff					
End-point royalties					

FOR OILSEEDS	Strongly Against	Moderately Against	Indifferent	Moderately For	Strongly for
Royalty imbedded in seed price					
Royalty paid through contract technology use agreements					
Mandatory checkoff					
Voluntary/refundable checkoff					
End-point royalties					

11. Multiple funding mechanisms (i.e. patents, checkoffs) are used in many crop categories. How concerned are you about the use of multiple or stacked mechanism for the same crop?

Strongly opposed	
Moderately opposed	
Indifferent	
Moderately support	
Strongly support	

THANK YOU. PLEASE RETURN THIS TO THE SURVEY MANAGER.

Version 2

SURVEY

1. Are you involved in farm-level related decision making?

Yes	
No	

IF NO, thank you for your interest. We have no further questions for you.

2. Imagine you are planning your crop production choices for 2017, and you plan on planting some lentils. You need an average return of 25 bu/a to earn your target profit on that crop. **You have 2 alternative crop varieties to choose from. Both are public varieties available without royalties but are subject to producer checkoffs**. If variety A is adopted, the crop will yield 5 bu/acre less than the target, if variety B is adopted, 1 in 4 fields will yield 7 bu/a more than the target and 3 out of 4 will yield 9 bu/a less than the target.

Variety A	
Variety B	

3. Imagine you are planning your crop production choices for 2017, and you plan on planting some lentils. You need an average return of 25 bu/a to earn your target profit on that crop. **You have 2 alternative crop varieties to choose from. Both are privately contracted niche varieties not subject to producer check-offs but obligated to pay end-point royalties of an equivalent amount**. If variety C is adopted the crop will yield 20 bu/a. If variety D is adopted, 1 in 4 fields will yield 32 bu/a but 3 out of 4 will yield 16 bu/ac.

Variety C	
Variety D	

Please tell us a little bit about yourself (Please tick the appropriate boxes or enter the data)

4. Have you seeded pulse crops (lentils, beans, peas) within the last 5 years?

Yes	
No:	

5. What Province do you farm in?

British Columbia	
Alberta	
Saskatchewan	
Manitoba	
Other	

6. How many acres of all crops did you seed on your farm in 2016?

7. How many acres did you plant in 2016 to:

Lentils	
Peas	
Chickpeas	
Fababeans	
Dry beans	

8. How many years have you been farming?

9. Where do you get information and advice on crop choices?

	Never	Occasionally	Sometimes	Frequently	Always
Family					
Agri-business companies					
Internet					
Media					
Agronomists					
Personal experience					
Other Farmers					

10. There are multiple ways to raise funds for research into agronomy and new varietal development. For the following questions, please indicate your preference by crop type:

FOR PULSES	Strongly Against	Moderately Against	Indifferent	Moderately For	Strongly for
Royalty imbedded in seed price					
Royalty paid through contract technology use agreements					
Mandatory checkoff					
Voluntary/refundable checkoff					
End-point royalties					

FOR CEREALS	Strongly Against	Moderately Against	Indifferent	Moderately For	Strongly for
Royalty imbedded in seed price					
Royalty paid through contract (e.g. technology use agreements)					
Mandatory checkoff					
Voluntary/refundable checkoff					
End-point royalties					

FOR OILSEEDS	Strongly Against	Moderately Against	Indifferent	Moderately For	Strongly for
Royalty imbedded in seed price					
Royalty paid through contract technology use agreements					
Mandatory checkoff					
Voluntary/refundable checkoff					
End-point royalties					

11. Multiple funding mechanisms (i.e. patents, checkoffs) are used in many crop categories. How concerned are you about the use of multiple or stacked mechanism for the same crop?

Strongly opposed	
Moderately opposed	
Indifferent	
Moderately support	
Strongly support	

THANK YOU. PLEASE RETURN THIS TO THE SURVEY MANAGER.

Appendix B – Consent Form

Participant Consent Form

Researcher: Stephen Fransoo, Masters of Public Policy Student, JSGS School of Public Policy, University of Saskatchewan, 1-306-261-1299, sjf413@mail.usask.ca

Supervisor: Dr. Peter Phillips, JSGS School of Public Policy, University of Saskatchewan 1-306-966-4021, peter.phillips@usask.ca

Purpose and Objective of the Research:

- The objective and purpose of this project are to investigate how different presentations and contexts affect producer seed purchasing decisions.
- Participation in this study involves answering 11 questions. This web-based questionnaire will take approximately 5 minutes
- Please feel free to ask any questions regarding the procedures and goals of the study or your role.

Potential Risks:

- There are no known risks to participating in this survey; however, as with any online related activity the risk of breach of confidentiality is always possible.
- At the end of the survey, there will be a debriefing form to remind you of the objectives, purposes of this study and directions that will give you access to a final draft of the study
- You can terminate your participation in this survey at any time by leaving the questionnaire web page. If you choose to terminate your involvement, your responses will not be recorded or used in this study

Confidentiality:

- All your responses are confidential and anonymous, no identifiable information will be collected
- Your responses will be used to complete my Master's thesis and when my project is complete your responses will be kept for 5 years in the digital database at the University of Saskatchewan Social Sciences Research Lab
- Your responses will be deleted 5 years after the completion of my Master's Thesis

Right to Withdraw:

- Your participation is voluntary and you can answer only those questions that you are comfortable with. You may withdraw from the research project for any reason, at any time without explanation or penalty of any sort.
- Should you wish to withdraw, your responses will not be recorded or used in this study

Follow up:

- To obtain the results of this study please contact the researchers at their email addresses provided above

Questions or Concerns:

- Contact the researcher(s) using the information at the top of page 1;
- This research project has been approved on ethical grounds by the University of Saskatchewan Research Ethics Board. Any questions regarding your rights as a participant may be addressed to that committee through the Research Ethics Office ethics.office@usask.ca (306) 966-2975. Out of town participants may call toll free (888) 966-2975.

If you wish to participate in this questionnaire, please fill in the form.

Appendix C – Debriefing Form

Debriefing Form

Thank you for participating in this study! The goal of this research is to shed light on farmer decision making, particularly when choices are framed differently. According to prospect theory, we tend to take greater risk when a question is framed as a loss and less risk when it framed as a gain regardless of the profit potential of both choices. The purpose of this study is to evaluate if the framing of questions affects a farmer's decision to purchase lentil seed that was funded by a producer checkoff or an end-point-royalty (EPR). The ratification of UPOV 91 in Canada gives developers of new varieties the ability to charge an end-point-royalty which could increase their return on investment and spur greater private sector investment in pulse research and development. This new EPR framework would compete with the current producer checkoff pulse breeding framework. Ultimately, producer seed purchasing decisions will decide which pulse breeding framework will succeed and this study will determine if farmers make choices based purely on profit or are there other factors such as the framing of choices or the seed funding mechanism itself that contribute to producer decision making.

In this study, we gave you one question where you choose between 2 EPR funded lentil varieties and one where you choose between 2 producer checkoff-funded varieties. Also, one of the questions was framed as a gain relative to the 25 bu/a reference and the other was framed as a loose relative to the reference point. In both question, you had the option of choosing a variety that generated you a guaranteed yield and a riskier option that gave you a 75% chance of generating a lower yield and a 25% chance of generating a higher yield that the guaranteed option. You may have noticed that if you added the values of the riskier options they equal that of the guaranteed option. As previously mentioned, other studies have found that even when the value of two choices are equal, in the domain of gain we tend to choose the guaranteed choice and in the domain of losing we tend to choose the riskier choice. There are two different versions of this questionnaire. In one of them, the question that was framed as a gain, lentil varieties are created under an EPR and the other question that was framed as a loss, lentil varieties were created under a producer checkoff system. In the other questionnaire, the funding mechanism is reversed. You also gave some demographic and business strategy questions that will allow us to see if there are correlations between these responses and farmer decision making. The purpose of this study to determine if varieties funded under an EPR framework changed producer lentil variety preferences.

Thank you for participating in this study! Your responses were completely anonymous and confidential. If you have any questions regarding this study, please email Stephen Fransoo (sjf413@mail.usask.ca) or Dr. Peter Phillips (peter.phillips@usask.ca). If you would like to obtain the results of this study, please contact the researchers at the above email addresses.

Best,
Stephen Fransoo
MPP Student, University of Saskatchewan

Appendix D: Cross Tabulations

The following tables involve respondents that answered "Frequently" or "Always" for each information source.

Demographics and Provenance to Information Sources Cross Tabulations							
	Family	Agri-business	Internet	Media	Agronomists	Personal Experience	Other Farmers
Pulses Seeded (%)	78.8	81.5	85.3	75.0	78.1	85.4	81.3
Province (%)							
Alberta	9.1	3.7	11.8	8.3	0	6.8	8.8
Saskatchewan	81.4	88.9	82.4	83.3	89.1	83.5	86.3
Manitoba	9.1	7.4	5.9	8.3	9.4	8.7	5.0
Others	0	0	0	0	1.6	0	0
Acres in 2016 (%)							
1-5000	60	69.8	68.8	72.7	68.8	63.4	67.1
5001-10000	30.8	18.9	28.1	27.3	18.8	30.7	24.1
10001-15000	1.5	5.7	3.1	0	4.7	3.0	3.8
15001-20000	7.7	5.7	0	0	7.8	3.0	5.1
Acres/crop (%)							
Lentils							
1-500	65	70.6	83.3	100	68	69.4	68
501-1000	0	0	0	0	0	0	0
1501-3000	15	17.6	16.7	0	16	19.4	20
3001-4500	0	0	0	0	4	2.8	0
4501-6000	20	11.8	0	0	12	8.3	12
Peas							
1-500	51.6	56	44.4	40	55.6	50	57.9
501-1000	35.5	28	44.4	40	25.9	35.2	28.9
1001-1500	12.9	16	11.1	20	18.5	13	10.5
1501-2000	0	0	0	0	0	1.9	2.6
Years farmed							
1-15	64.5	46.3	45.5	33.3	46	42.9	52.6
16-30	21	24.1	27.3	33.3	25.4	27.6	23.1
31-45	14.5	25.9	27.3	33.3	25.4	27.6	23.1
46-60	0	3.7	0	0	3.2	2.0	1.3

Provenance by Commodity (%)							
Cereals							
Royalty in Seed Price							
Strongly Against	15.2	13.7	14.7	0	13.6	15.2	11.7
Moderately Against	16.7	17.6	20.6	25	23.7	20.2	18.2

Indifferent	36.4	27.5	29.4	25	27.1	27.3	28.6
Moderately For	22.7	29.4	26.5	25	27.1	28.3	28.6
Strongly For	9.1	11.8	8.8	25	8.5	9.1	10
TUA							
Strongly Against	15.2	15.7	17.6	16.7	18.6	19.4	13
Moderately Against	19.7	27.5	17.6	41.7	22	21.4	23.4
Indifferent	39.4	33.3	41.2	25	32.2	34.7	35.1
Moderately For	24.2	23.5	20.6	17.7	25.4	22.4	26
Strongly For	1.5	0	2.9	0	1.7	2	2.6
Mandatory Checkoff							
Strongly Against	10.6	11.5	8.8	8.3	11.7	15.2	14.1
Moderately Against	30.3	25	32.4	41.7	26.7	23.3	25.6
Indifferent	33.3	28.8	26.5	25	30	30.3	29.5
Moderately For	19.7	23.1	14.7	8.3	18.3	24.2	23.1
Strongly For	6.1	11.5	17.6	16.7	13.3	7.1	7.7
Voluntary Checkoff							
Strongly Against	10.8	15.1	17.6	16.7	9.7	16	11.5
Moderately Against	9.2	7.5	8.8	8.3	8.1	8	7.7
Indifferent	32.3	28.3	17.6	33.3	27.4	24	28.2
Moderately For	33.8	34	29.4	25	33.9	34	33.3
Strongly For	13.8	15.1	26.5	16.7	21	18	19.2
EPR							
Strongly Against	12.3	17.6	14.7	16.7	11.9	14.4	15.8
Moderately Against	18.5	17.6	14.7	8.3	20.3	17.5	17.1
Indifferent	38.5	29.4	26.5	25	37.3	35.1	34.2
Moderately For	18.5	17.6	26.5	25	20.3	21.6	18.4
Strongly For	12.3	17.6	17.6	25	10.2	11.3	14.5
Oil Seeds							
Royalty in Seed Price							
Strongly Against	15.4	10	20.6	8.3	16.9	15.3	13
Moderately Against	13.8	20	20.6	33.3	22	18.4	19.5
Indifferent	27.7	24	35.3	0	25.4	28.6	27.3
Moderately For	35.4	36	20.6	41.7	27.1	30.6	31.2
Strongly For	7.7	10	2.9	16.7	8.5	7.1	9.1

TUA							
Strongly Against	10.8	16	17.6	8.3	16.9	16.2	10.4
Moderately Against	21.5	22	20.6	41.7	16.9	23.2	23.4
Indifferent	36.9	34	35.3	8.3	33.9	37.4	36.4
Moderately For	30.8	28	23.5	33.3	27.1	21.2	27.3
Strongly For	0	0	2.9	8.3	5.1	2	2.6

Mandatory Checkoff							
Strongly Against	13.8	11.8	8.8	8.3	11.7	16.2	15.4
Moderately Against	26.2	23.5	29.4	41.7	25	22.2	21.8
Indifferent	32.2	25.5	26.5	0	21.7	27.3	29.5
Moderately For	26.2	27.5	20.6	33.3	26.7	27.3	25.6
Strongly For	1.5	11.8	14.7	16.7	15	7.1	7.7
Voluntary Checkoff							
Strongly Against	9.2	15.4	17.6	25	12.9	15.8	11.5
Moderately Against	10.8	5.8	8.8	8.3	4.8	6.9	6.4
Indifferent	35.4	34.6	23.5	16.7	32.3	29.7	37.2
Moderately For	36.9	28.8	26.5	33.3	32.3	31.7	28.2
Strongly For	7.7	15.4	23.5	16.7	17.7	15.8	16.7
EPR							
Strongly Against	14.1	18	17.6	27.3	13.6	15.5	16.9
Moderately Against	17.2	12	8.8	9.1	16.9	15.5	15.6
Indifferent	34.4	30	29.4	18.2	35.6	35.1	33.8
Moderately For	18.8	26	29.4	27.3	23.7	22.7	20.8
Strongly For	15.6	14	14.7	18.2	10.2	11.3	13
Pulses							
Royalty in Seed Price							
Strongly Against	15.2	15.4	14.7	25	13.1	18.2	13.9
Moderately Against	9.1	9.6	14.7	58.3	16.4	12.1	12.7
Indifferent	28.8	23.1	29.4	0	19.7	28.3	25.3
Moderately For	36.4	36.5	35.3	0	37.7	32.3	35.4
Strongly For	10.6	15.4	5.9	16.7	13.1	9.1	12.7
TUA							
Strongly Against	13.6	15.7	11.8	16.7	18.3	18.2	12.7
Moderately Against	19.7	21.6	23.5	41.7	16.7	18.2	24.1
Indifferent	33.3	25.5	35.3	8.3	28.3	35.4	26.6
Moderately For	31.8	33.3	23.5	33.3	33.3	25.3	34.2
Strongly For	1.5	3.9	5.9	0	3.3	3	2.5

Mandatory Checkoff							
Strongly Against	15.2	15.7	11.8	25	15	18	19
Moderately Against	25.8	23.5	26.5	33.3	25	21	20.3
Indifferent	31.8	27.5	32.4	0	30	31	31.6
Moderately For	24.2	29.4	14.7	33.3	25	25	24.1
Strongly For	3	3.9	14.7	8.3	5	5	5.1
Voluntary							

Checkoff							
Strongly Against	9.1	17	14.7	25	12.7	15.7	12.5
Moderately Against	9.1	3.8	8.8	8.3	6.3	6.9	6.3
Indifferent	31.8	37.7	20.6	25	30.2	27.5	35
Moderately For	39.4	28.3	35.3	33.3	36.5	35.3	30
Strongly For	10.6	13.2	20.6	8.3	14.3	14.7	16.3
EPR							
Strongly Against	18.2	21.6	17.6	33.3	20	19.2	19
Moderately Against	13.6	9.8	11.8	16.7	15	15.2	15.2
Indifferent	36.4	31.4	32.4	8.3	38.3	36.4	36.7
Moderately For	19.7	27.5	26.5	33.3	21.7	21.2	20.3
Strongly For	12.1	9.8	11.8	8.3	5	8.1	8.9

Multiple Funding Mechanism	Strongly Opposed	Moderately Opposed	Indifferent	Moderately Support	Strongly Support
Family (%)	21.2	27.3	31.8	18.2	1.5
Agri-Business (%)	31.5	25.9	20.4	20.4	1.9
Internet (%)	17.6	32.4	32.4	14.7	2.9
Media (%)	33.3	25	25	8.3	8.3
Agronomists (%)	32.8	23.4	28.1	14.1	1.6
Personal Experience (%)	28.2	26.2	31.1	14.6	0
Other Farmers (%)	26.3	28.8	27.5	16.3	1.3

Appendix E: Survey Data

Q1	Version	Q2 C/G	Q2 C/L	Q2 EPR L	Q2 EPR/G	Q4	Q5	Q6	Q7 L	Q7 P	Q7 C	Q7 F	Q7 D	Q8	Q9 Family
1	1	2		1		1	3	6500		1000				15	2
1	2		2		1	1	4	3200		460				18	5
1	1	1		2		1	4	5000		130				14	2
1	1	1		2		1	4	6600	0	1000	0	0	0	15	2
1	1	1		1		2	3	3900	0	0	0	0	0	12	2
1	2		1		2	1	3	4500	0	900	0	0	0	40	3
1	1	1		1		1	4	2850	0	0	0	0	0	11	3
1	2		2		1	1	3	3000		500				6	2
1	2		1		1	1	3	4400	1760	0	0	0	0	31	1
1	1	1		1		1	4	3000		450				20	5
1	2		1		1	1	3	5000	0	900	0	0	320	20	3
1	1	1		1		1	2	5500	160	1200	0	0	0	15	4
1	1	1		1		1	3	6000	1100	0	0	0	0	15	5
1	2		1		1	2	5	865	0	0	0	0	0	35	1
1	2		1		1	1	2	9000	3000	0	0	0	0	17	3
1	2		1		1	2	4	8800	0	0	0	0	0	5	5
1	1		1		1	1	3	2200	600					32	3
1	2		1		1	1	3	2100		450		30		6	3
1	2		2		2	1	2	5000	450	800	0	300	0	10	4
1	2		1		1	1	2	2000	0	300	0	0	80	30	3
1	2		1		1	1	4	6500	0	0	0	0	0	32	4
1	2		1		2	1	3	10000	140	400				24	2
1	2		1		2	1	3	10000	0	0	0	0	0	5	4
1	1	1		2		1	3	3800	1000					40	1
1	1	1		2		1	4	2000	0	0	0	0	0	12	3
1	1	2		2		1	3	1000		1000					4
1	1	1		1		1	3	504		250				35	3
1	2		1		1	1	3	10000	0	0	0	0	0	5	4
1	1	1		2		1	3	5000	12	500				11	1
1	2		1		2	1	2	2000	0	400	0	0	0	4	5
1	1	2		2		1	3	2000	1	600	0	1	1	1	3
1	1	1		1		1	3	756	0	280	0	0	0	21	1
1	1	2		2		1	3	5000	1500	1000	0	0	0	15	4
1	1	2		2		1	3	3600	0	0	0	0	0	6	5
1	1	1		2		1	3	7200	0	0	0	0	0	10	5
1	1	1		1		1	2	7200	0	640	0	0	0	4	4
1	1	2		2		1	3	7200	0	600	0	0	0	35	2
1	1	1		1		1	3	7700	0	500	0	0	0	7	4
1	1	1		1		1	3	8000	0	400	0	0	0	23	4
1	1	1		1		1	2	4000	0	900	0	0	0	13	5
1	1	1		2		1	3	3600	0	0	0	0	0	33	4
1	1	2		1		2	3	300	0	0	0	0	0	1	5
1	1	1		2		1	3	13700	300	1500	0	0	0	29	2
1	1	1		1		1	3	8500	2000	2000	2000	640	0	40	2
1	1	2		1		1	3	3000	0	500	0	0	0	50	2
1	1	2		1		1	3	1000	280	0	0	0	0	20	4
1	1	2		2		1	3	1000	160	0	0	0	0	23	2
1	1	2		2		2	3	1750	0	0	0	0	0	45	4
1	1	2		2		2	3	300	0	0	0	0	0	1	5
1	1	1		1		1	3	1850	0	480	0	0	0	35	1
1	1	1		1		1	3	4800	700	800	0	0	0	10	3
1	1	2		2		1	3	7500	60	0	0	0	0	30	1
1	1	2		1		1	3	7500	2000	0	0	0	0	10	5
1	1	1		1		1	3	3100	0	900	0	0	1100	11	4
1	1	1		1		1	3	5800	0	0	0	0	0	12	4
1	1	1		2		2	3	700	300	0	0	0	0	0	5
1	1	2		2		1	3	10000	0	0	0	0	0	30	3
1	1	1		1		1	3	4000	160	640	0	0	0	6	4
1	1	2		2		2	3	20000	0	0	0	0	0	14	5
1	1	1		2		1	3	3000	2000	0	0	0	0	11	4
1	1	1		1		1	2	2500	0	700	0	0	0	40	3
1	1	1		2		1	3	3600	0	400	0	0	0	44	2
1	1	2		2		2	3	1500	0	0	0	90	0	11	3
1	1	2		1		1	3	17500	5000	0	0	0	0	23	1
1	1	1		1		1	3	17500	5000	0	0	0	0	6	4
1	1	1		1		1	3	1000	0	350	0	0	0	22	2
1	1	2		2		1	3	5000	0	1200	0	0	0	40	5
1	1	1		1		1	3	20000	600	1200	0	0	0	50	
1	1	1		1		1	3	3200	0	0	0	0	0		2
1	1	2		2		2	3	2400	0	0	0	0	0	33	4
1	1	1		2		1	3	5150	2000	0	3000	50	0	59	1
1	1	2		2		2	3	1900	0	0	0	0	0	10	5
1	1	2		2		2	3	360	0	0	0	0	0	3	4
1	1	2		2		1	3	2000	0	0	0	0	0	32	2
1	1	2		2		1	3	1200	0	320	0	0	0	12	4
1	1	1		1		2	3	8200	0	0	0	0	0	10	3
1	1	1		1		1	3	5600	0	300	0	0	0	6	4
1	1	1		1		2	2	1200	0	0	0	0	0	5	4
1	1	1		1		1	3	1000	300	0	0	0	0	40	3
1	1	1		2		2	3	1600	0	0	0	0	0	25	2
1	1	2		1		1	3	4000	0	0	0	580	0	36	2
1	1	2		1		1	3	28000	0	0	0	0	0	40	3
1	1	2		1		1	4	9200	245	1100	0	0	180	6	4
1	2		2		2	1	3	3600	0	0	0	0	0	30	4
1	2		2		2	1	3		0	620	0	0	0	36	4
1	2		1		1	1	3	7200	0	640	0	0	0		4
1	2		1		1	1	3	7200	0	400	0	0	0	7	4
1	2		1		1	2	3	900	0	0	0	0	0	10	3
1	2		1		1	2	3	3500	0	0	0	0	0	56	3
1	2		1		1	2	3	300	0	0	0	0	0	1	5
1	2		1		2	1	3	13700	300	1500	0	0	0	33	3
1	2		1		1	1	3	1250	360	360	0	0	0	1	5
1	2		1		1	1	3	9000	3200	1100	0	0	0	20	2
1	2		1		1	1	3	2500	1100	0	0	0	0	25	4
1	2		2		2	2	3	1750	0	0	0	0	0	10	4
1	2		2		1	2	3	2700	0	0	0	0	0	42	5
1	2		1		1	1	3	5000	1000	1000	0	0	0	5	4
1	2		1		2	1	3	3000	0	160	0	0	0	35	
1	2		1		2	1	3		1000	1000	0	0	0	40	2
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Q9 AG Buisness	Q9 Internet	Q9 Media	Q9 Agronomist	Q9 Personal	Q9 Other Farmers	Q10 P RIS	Q10 P TUA	Q10 P MC	Q10 P VC	Q10 P EPR	Q10 C RIS	Q10 C TUA	Q10 C MC	Q10 C VC	Q 10 C EPR	Q10 O RIS	Q10 O TUA	Q10 O MC	Q10 O VC	Q10 O EPR	Q11
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